RAM PIPE REQUAL:

A Risk Assessment & Management Based Process for the Requalification of Marine Pipelines

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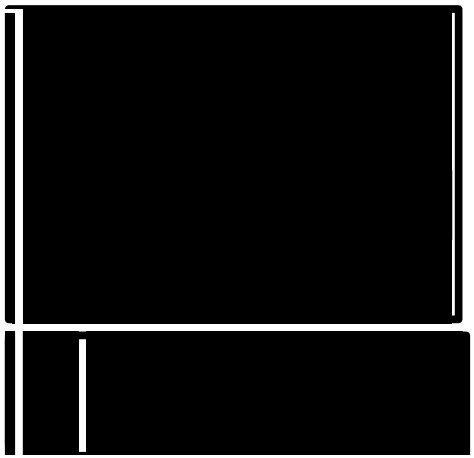
Topics

- **RAM PIPE REQUAL**
- **Reliability Approach**
- **Level 2 examples: corrosion**
  - **Un-instrumented**
  - **Instrumented**

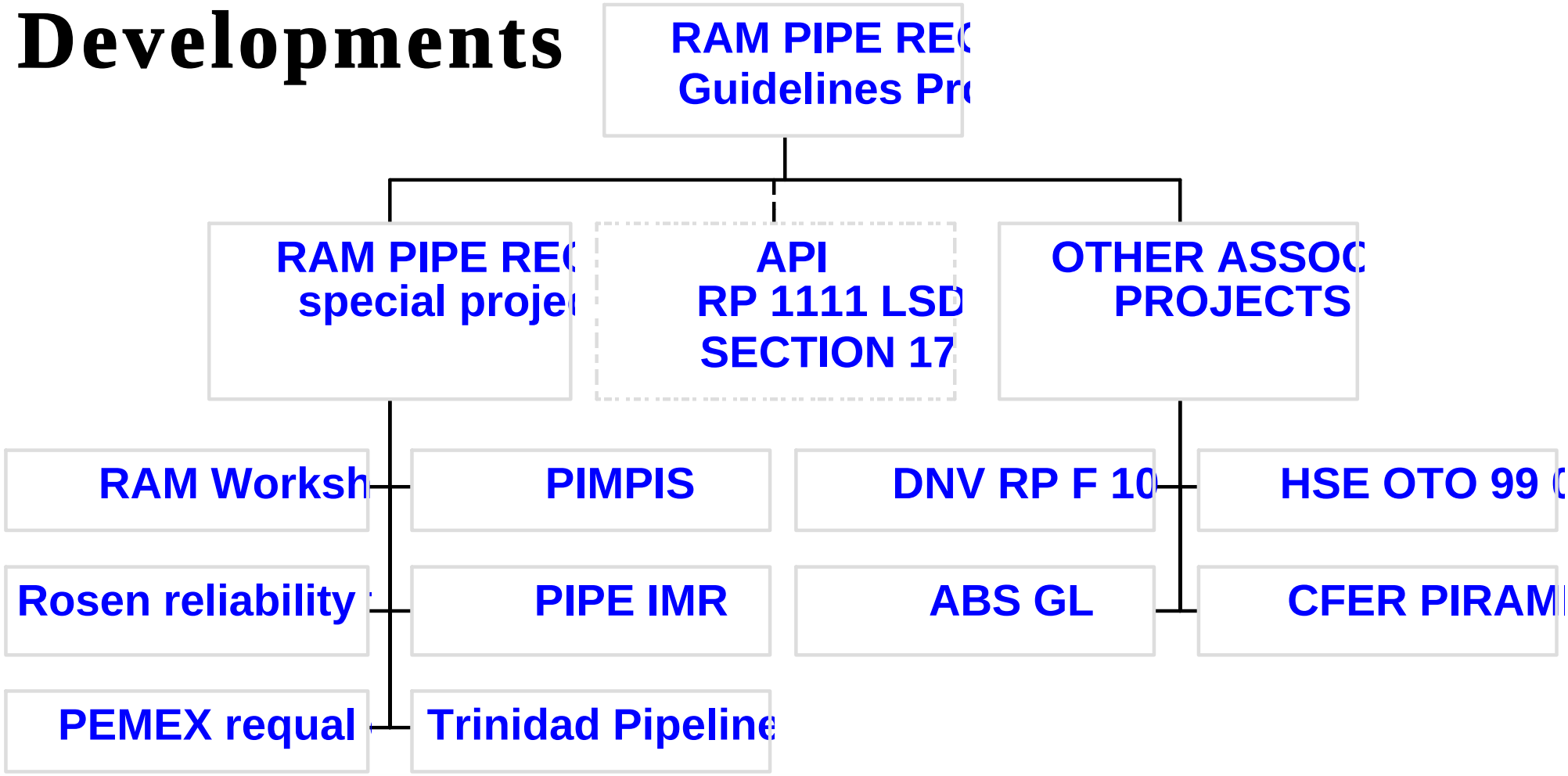
RAM PIPE REQUAL Project

Develop guidelines for requalification of marine pipelines

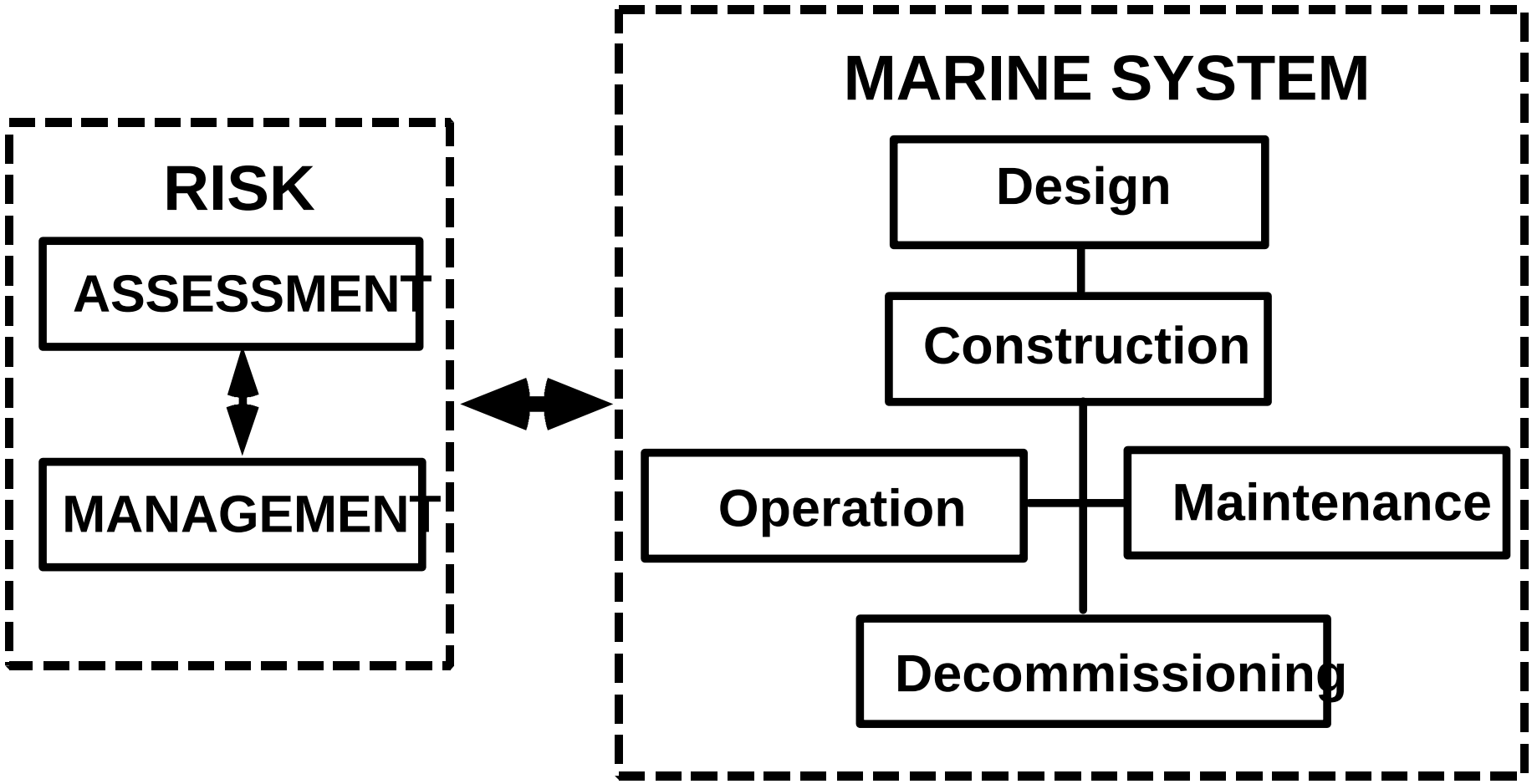


MMS Minerals Management Service

Associated Developments



RAM


RISK
ASSESSMENT
MANAGEMENT
MARINE SYSTEM
Design
Construction
Operation
Maintenance
Decommissioning

Risk Assessment

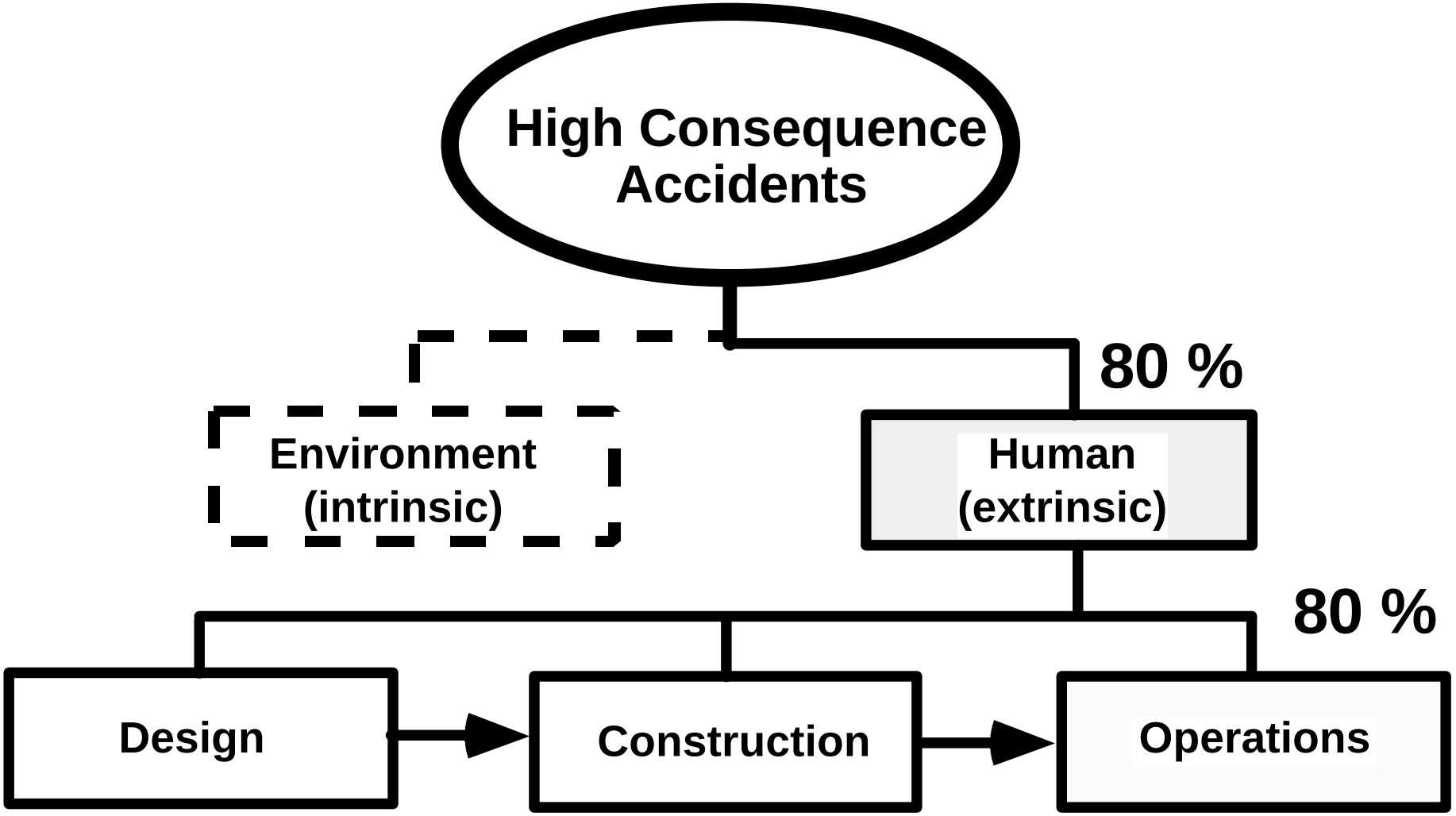
- Risks: likelihoods & consequences
- Hazards: uncertainties, threats
- Knowable & unknowable hazards
- Assessment: identify & evaluate
- Alternatives:likelihoods, consequences, both
- Observe: improve & revise

Risk Management

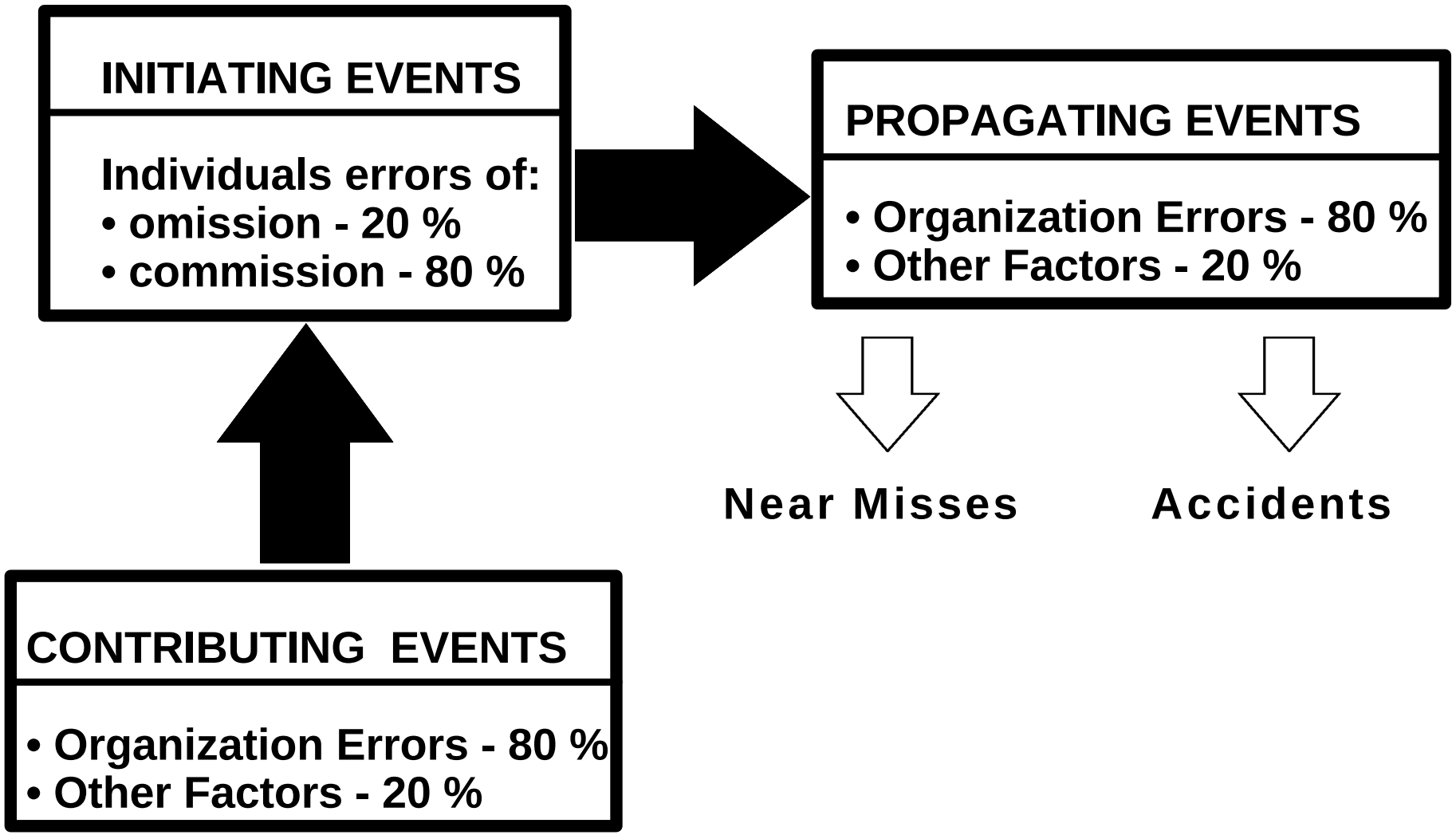
- Alternatives: evaluate, costs, benefits
- Culture: production & protection
- Identify: alternatives
- Resources: abilities, money, time
- Implementation: plan, organize, lead, control
- Revise: monitor, assess, modify

Accidents are caused by people

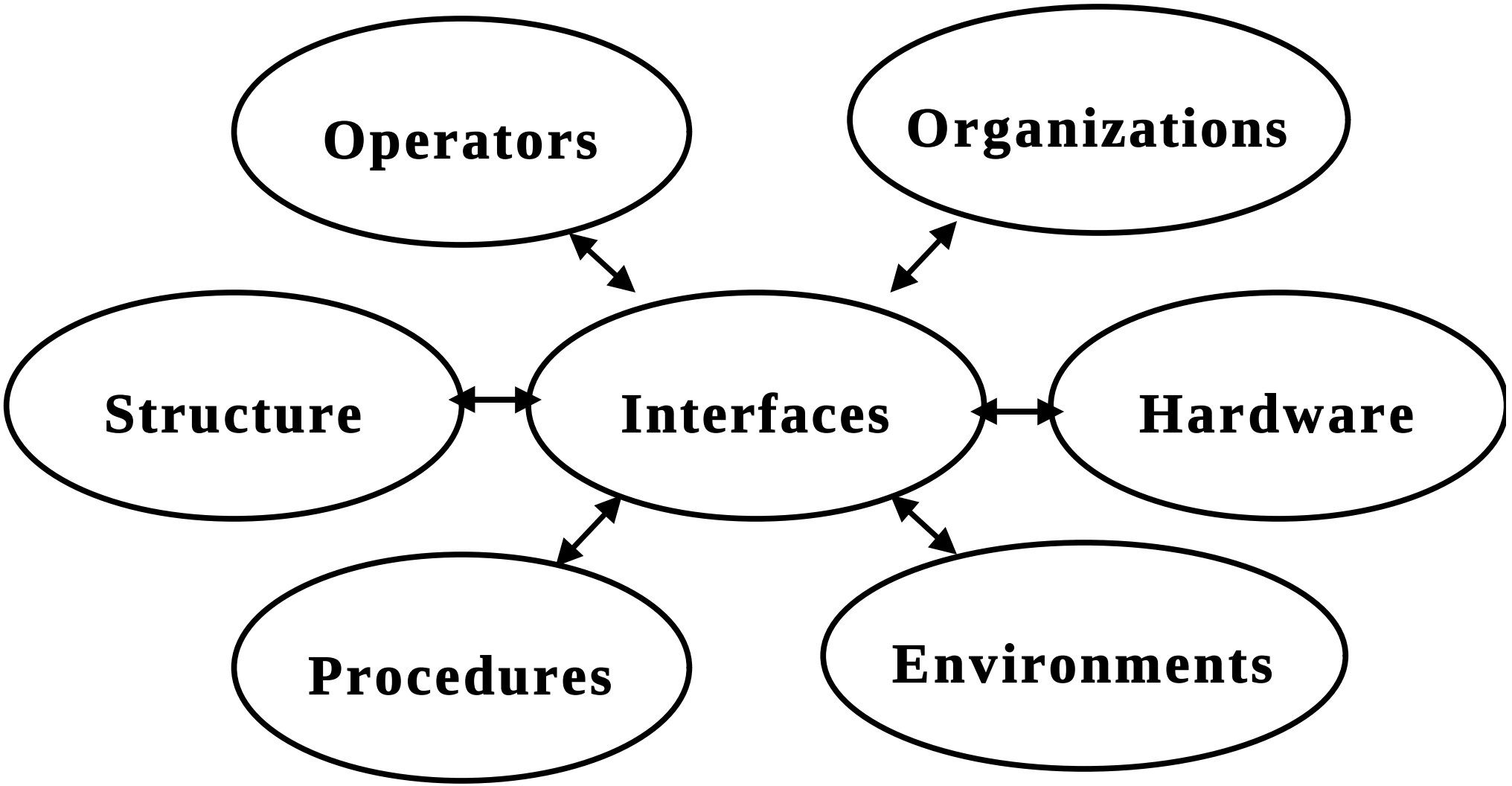
and so are successes



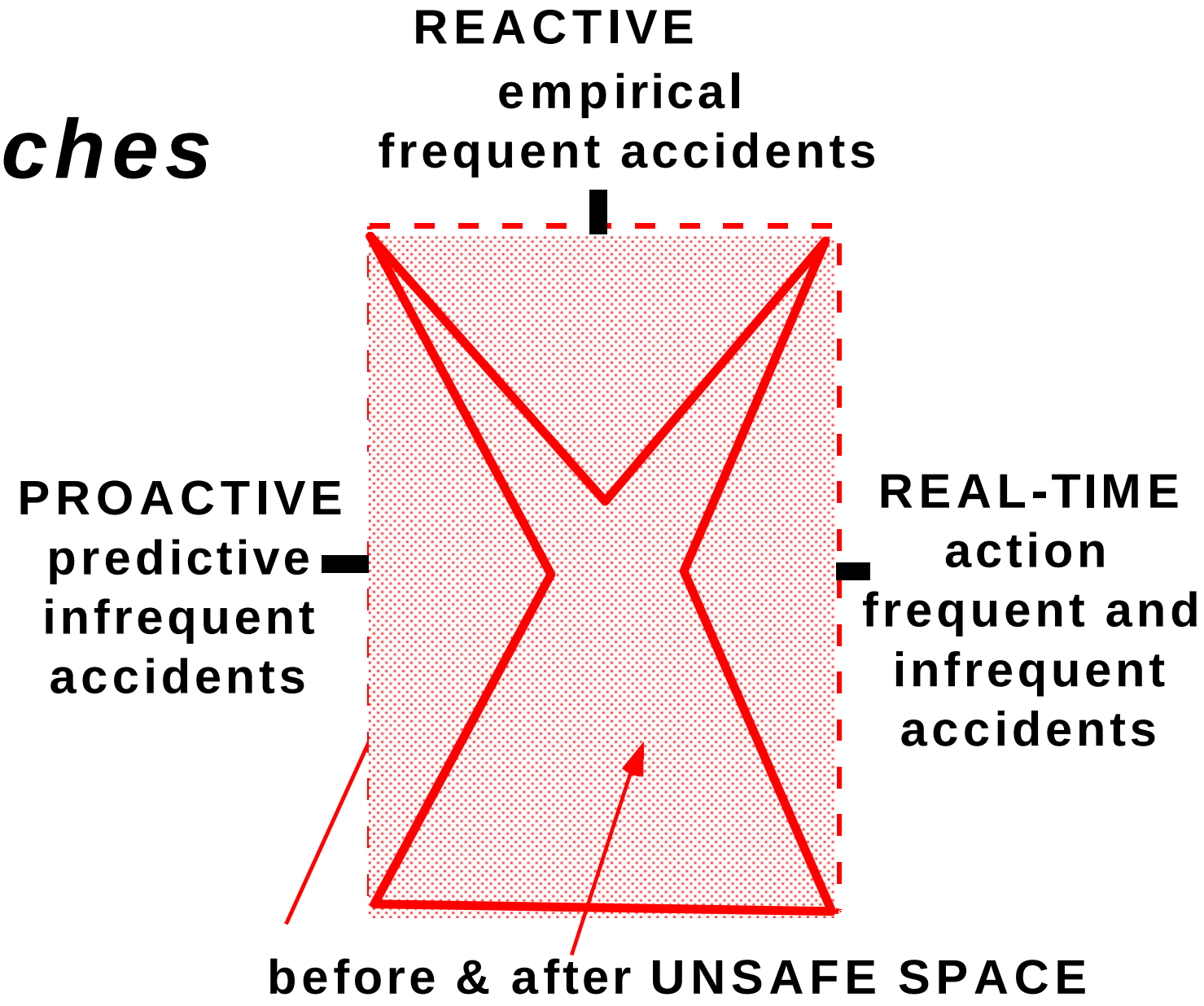
Organizations have major influences



Primary factors



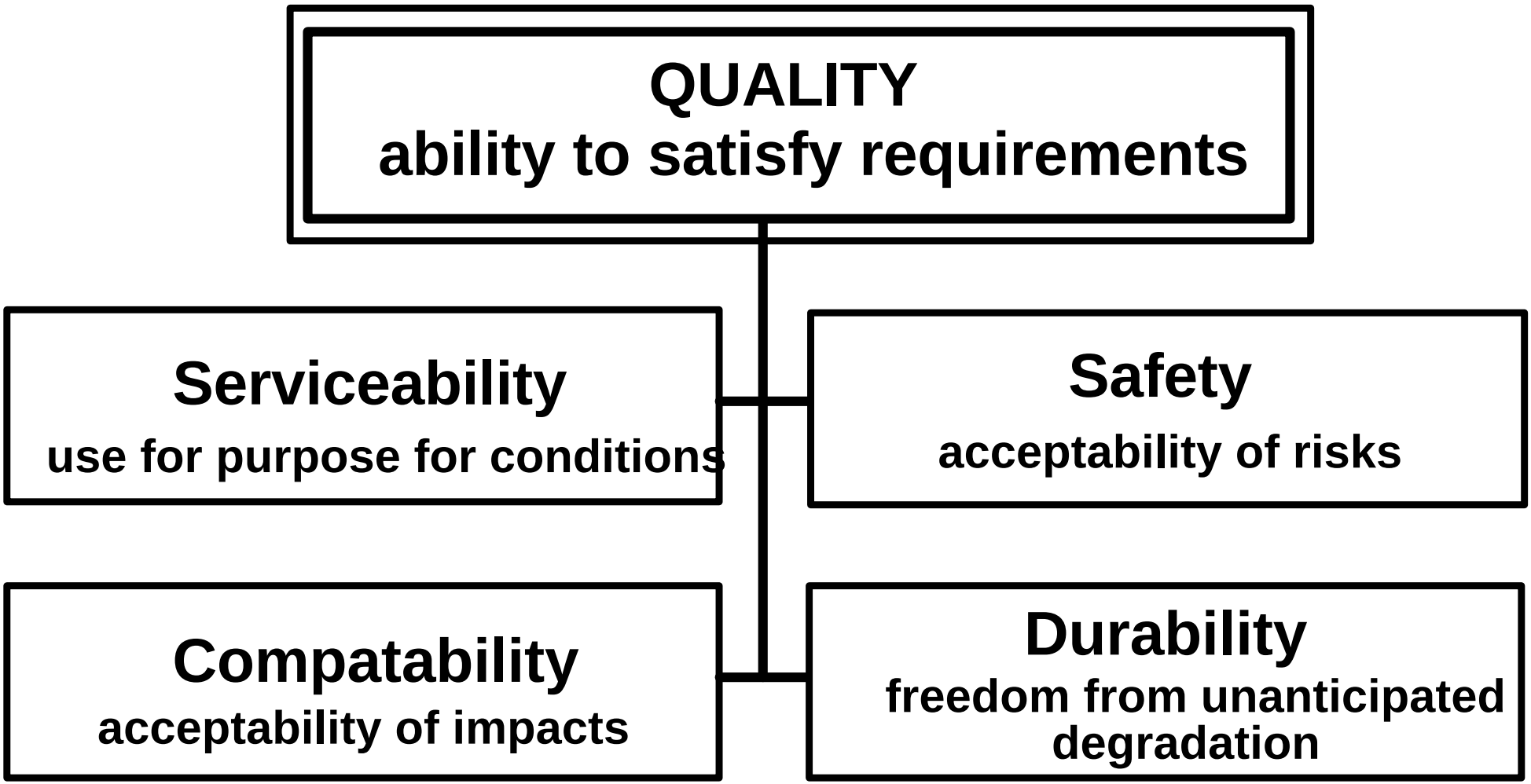
Approaches


REACTIVE
empirical
frequent accidents
PROACTIVE
predictive
infrequent
accidents
REAL-TIME
action
frequent and
infrequent
accidents
before & after UNSAFE SPACE

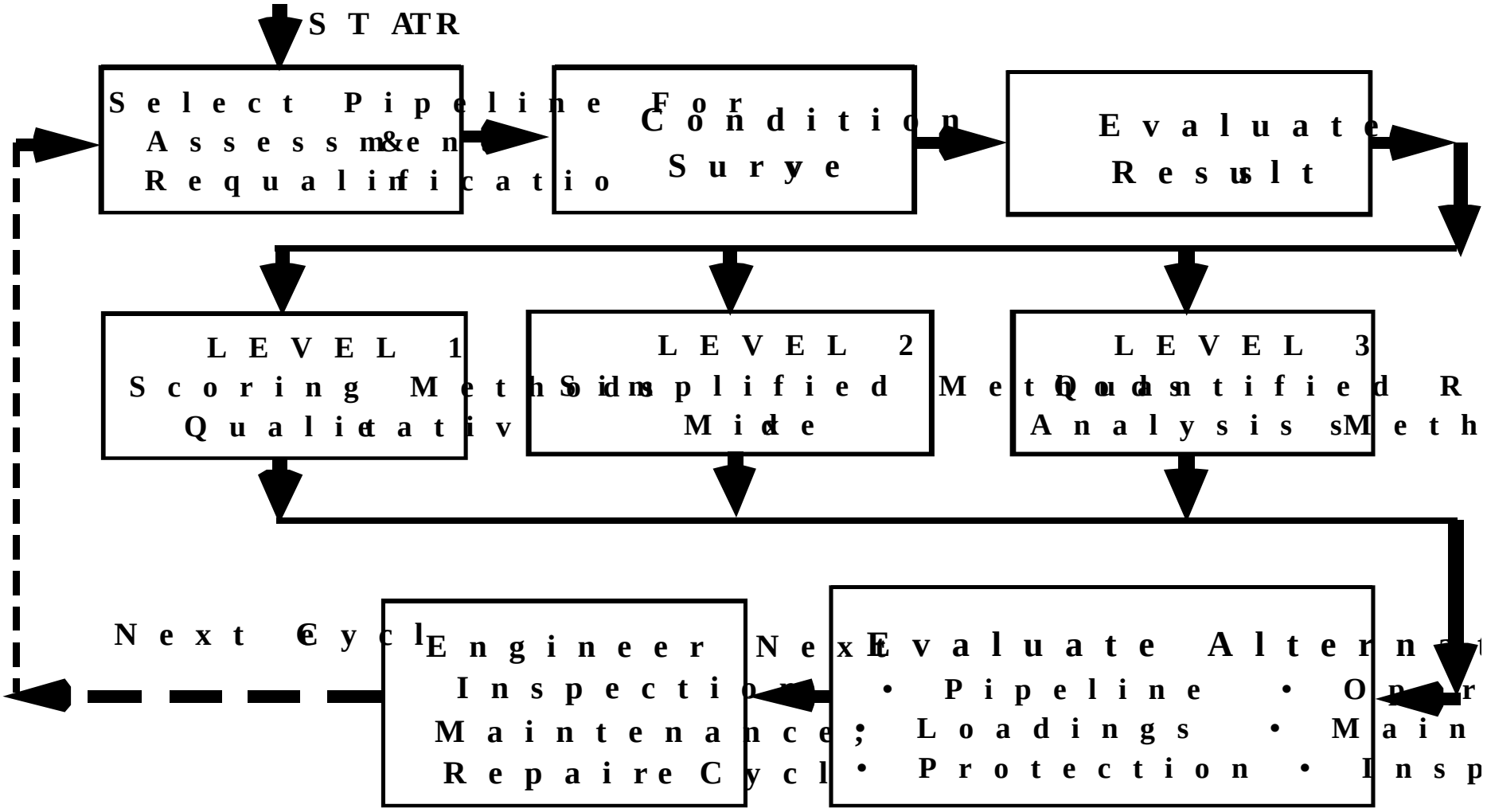
Three key strategies

- **Reduce the likelihood of HOE**
- **Increase detection & remediation of HOE**
- **Reduce the effects of HOE**

Quality, safety, & reliability



RAM PIPE REQUAL



RAM PIPE REQUAL

Level 2 Method

- **Base on physics - mechanics**
- **Simplified models**
- **RAM approach**
- **Performance databases**
- **Test data verified**
- **Instrumented & un-instrumented**
- **Linguistic & quantitative variables**

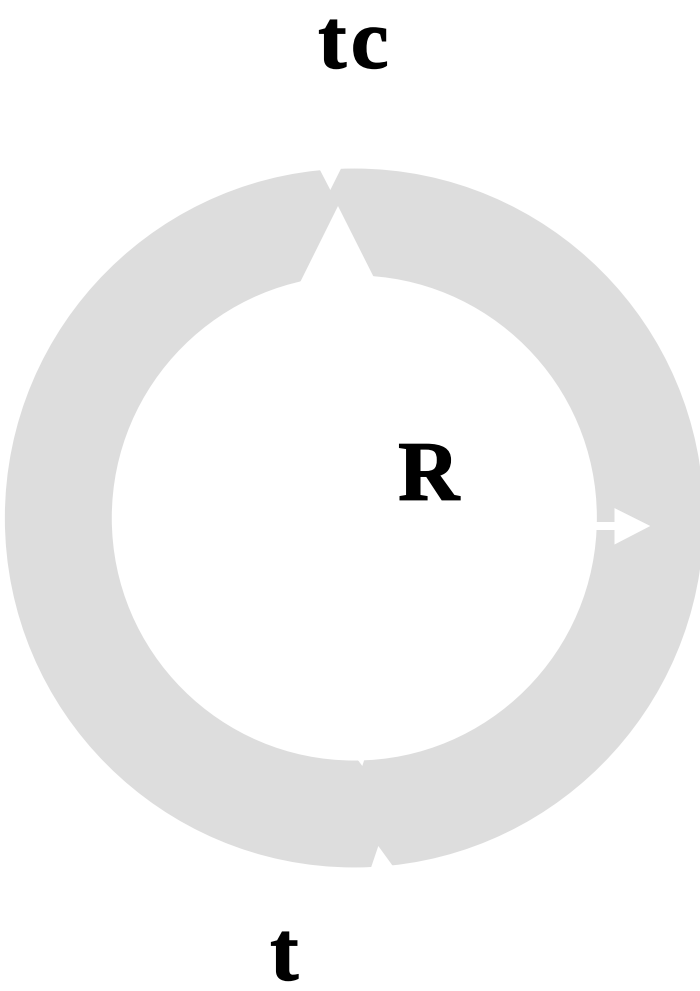
Level 2 Burst Capacity

Damaged / Defective

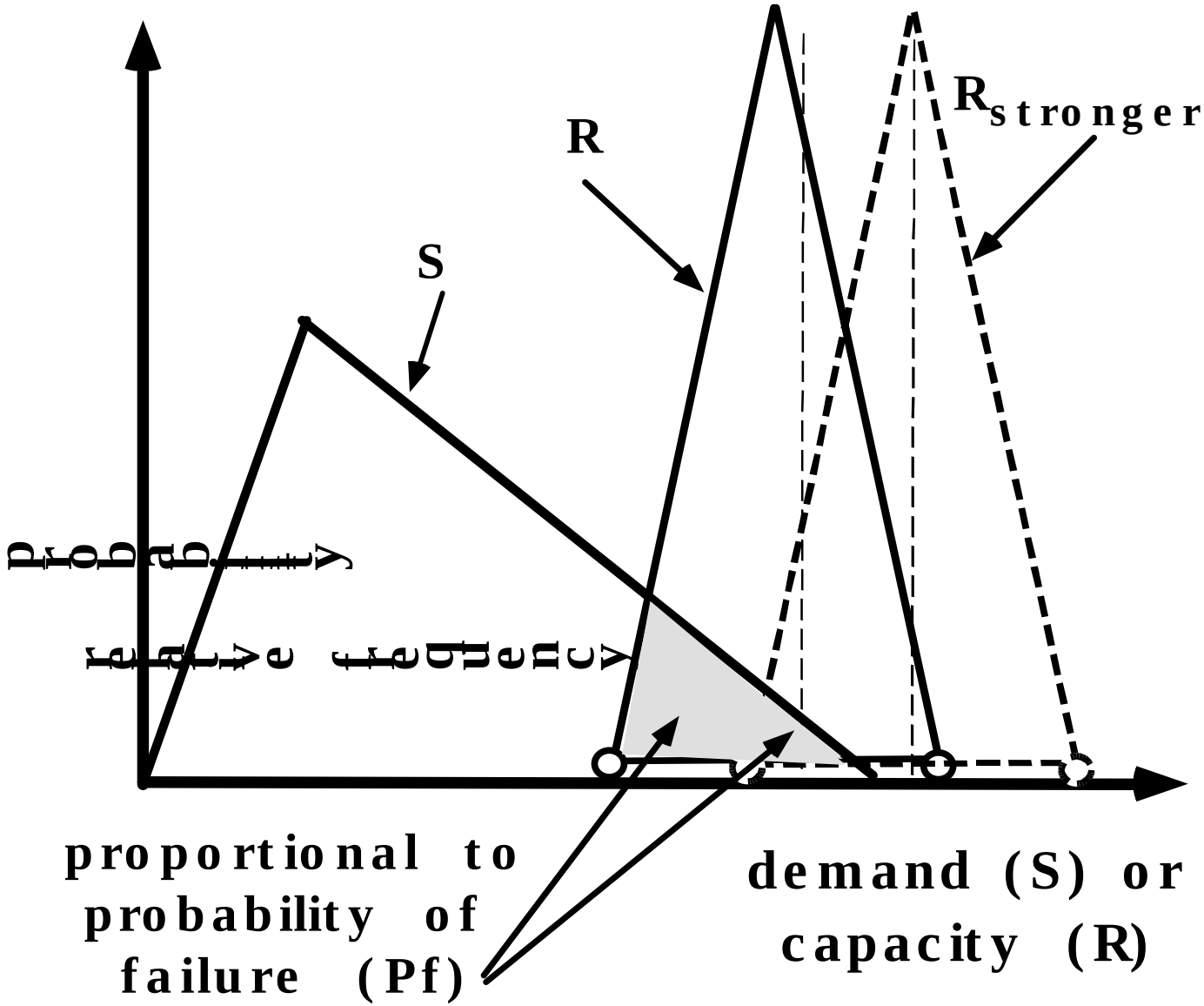
- **Intact:** $p_B = S_U\,(t / R)$
- **Corrosion**

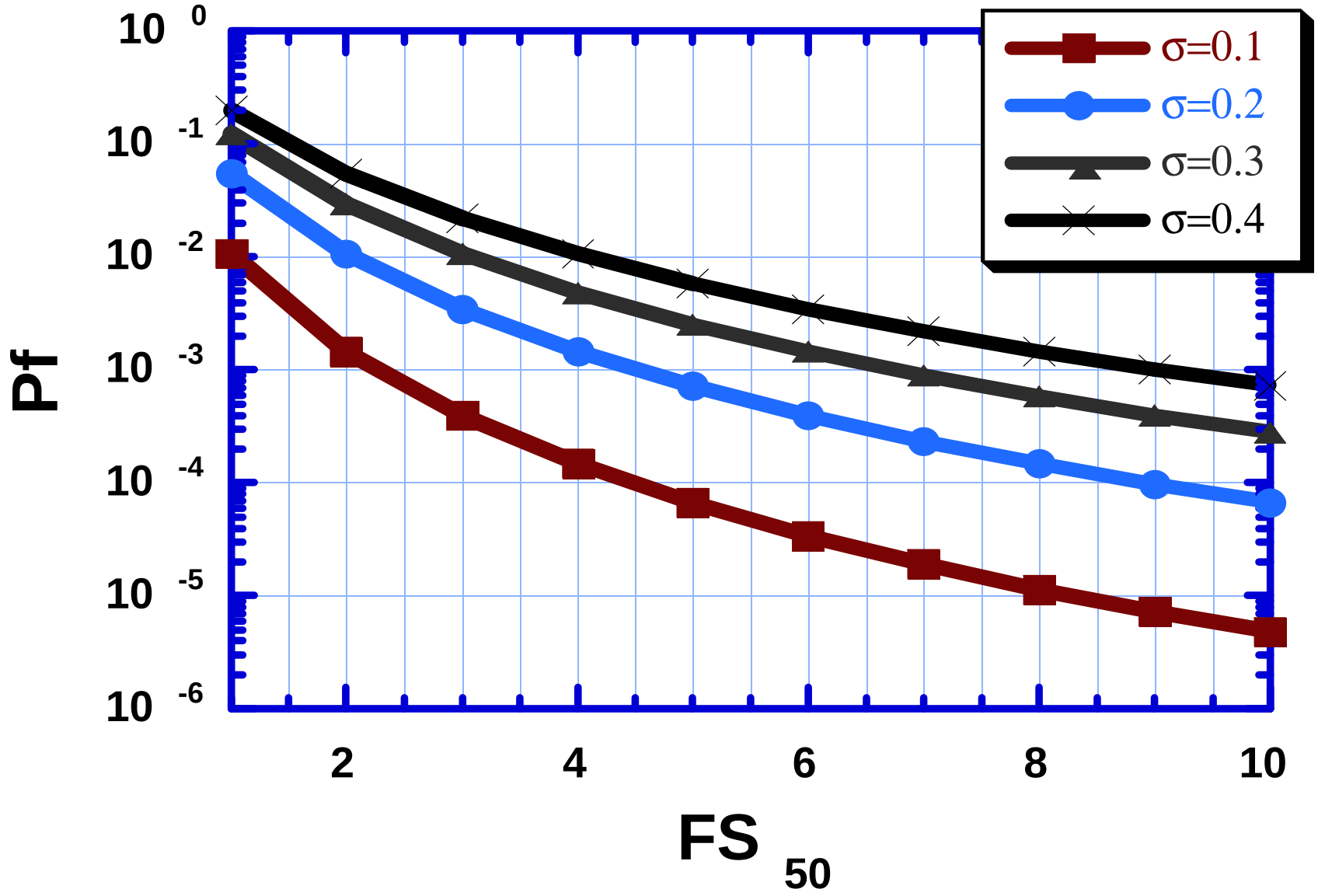
$$p_B = (S_U / SCF_C)(t / R)$$

$$SCF_C = 1+2(tc / R)^{0.5}$$



Pf = P [Demand (S) " Capacity (R)]

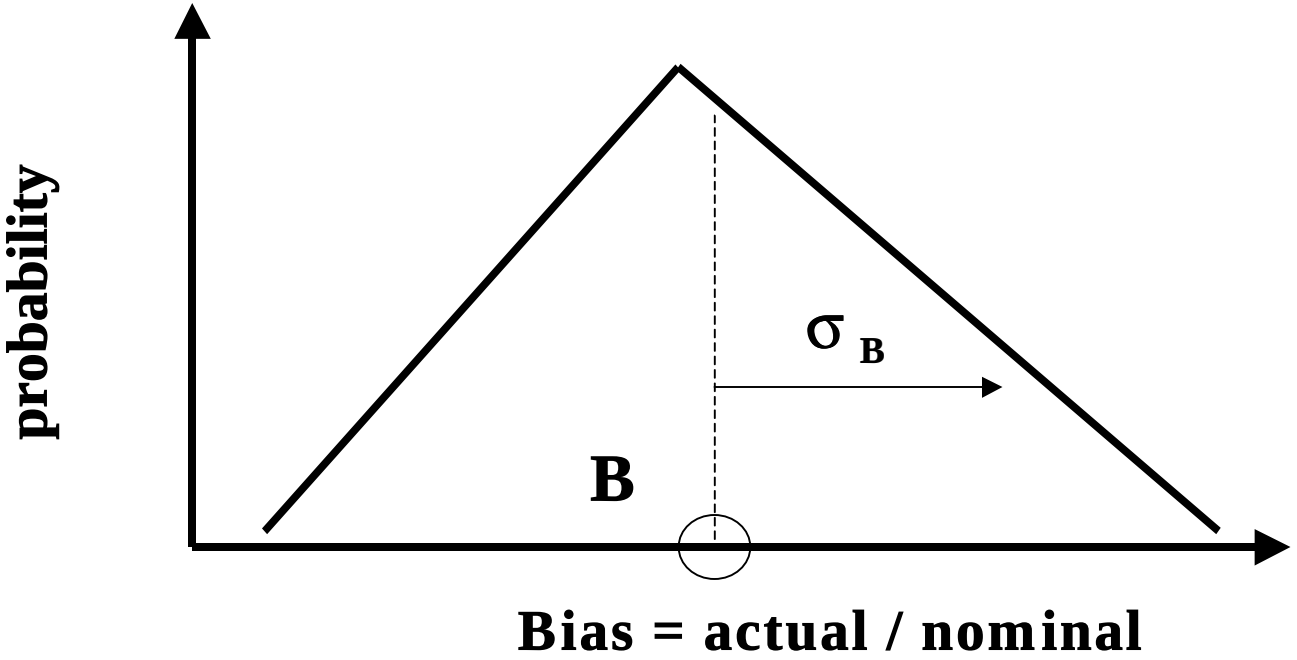


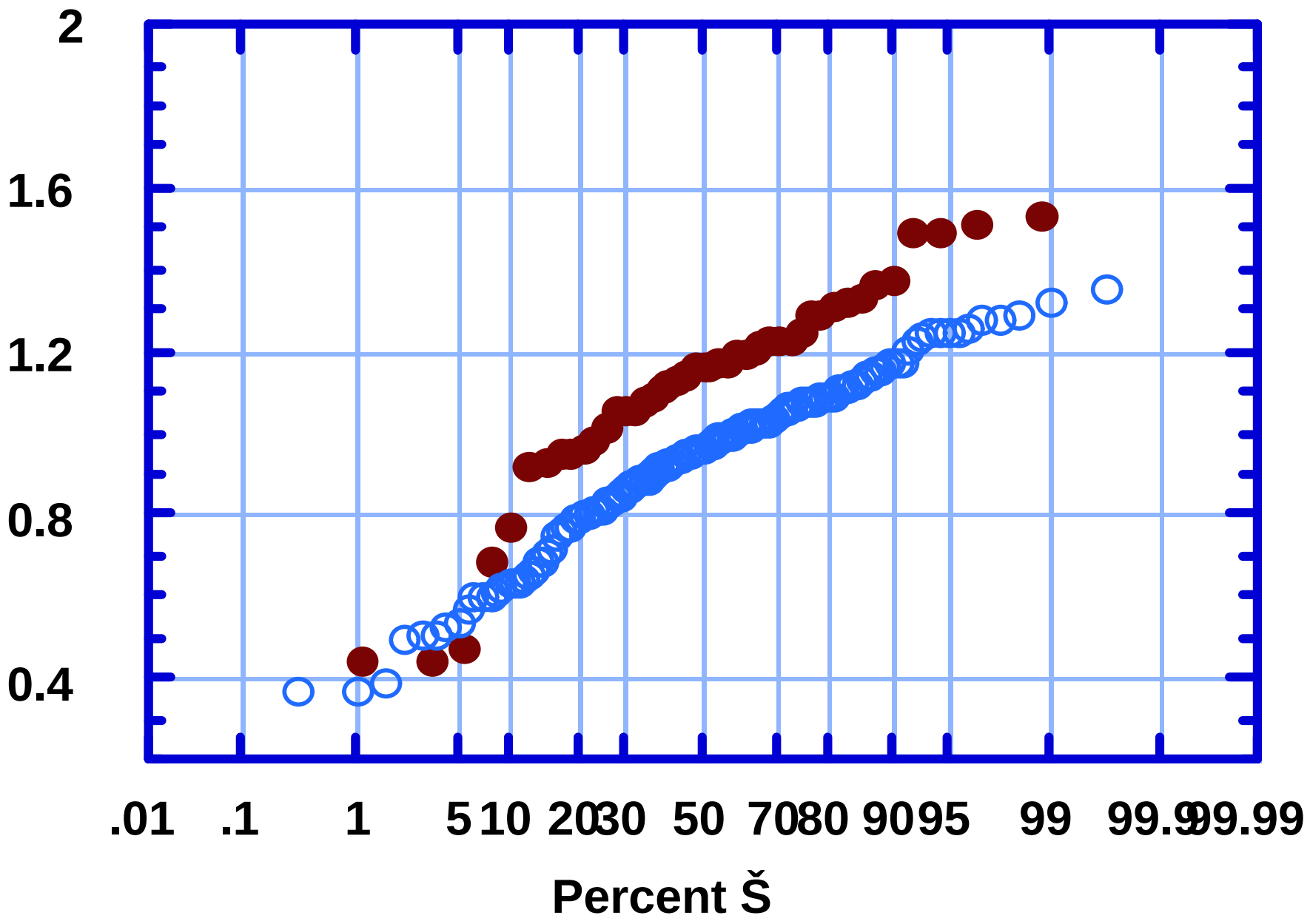

Pf
10 0
10 -1
10 -2
10 -3
10 -4
10 -5
10 -6
2
4
6
8
10
FS 50
σ=0.1
σ=0.2
σ=0.3
σ=0.4

Nominal Values & Biases

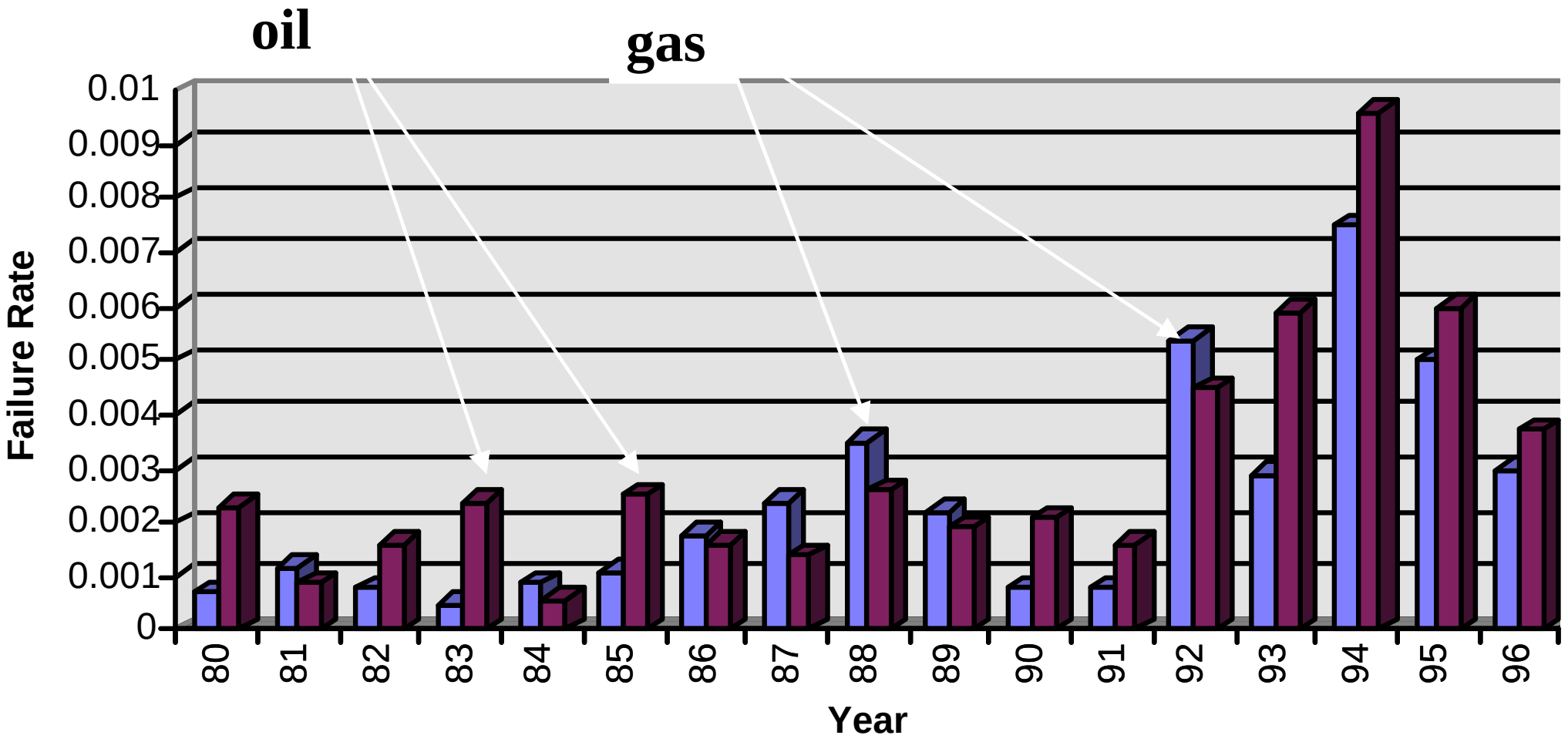
$$p_B = p_O \, (B_{pO} / B_{pB}) \exp(\beta\sigma) =$$

$$p_O \, B \exp(\beta\sigma)$$

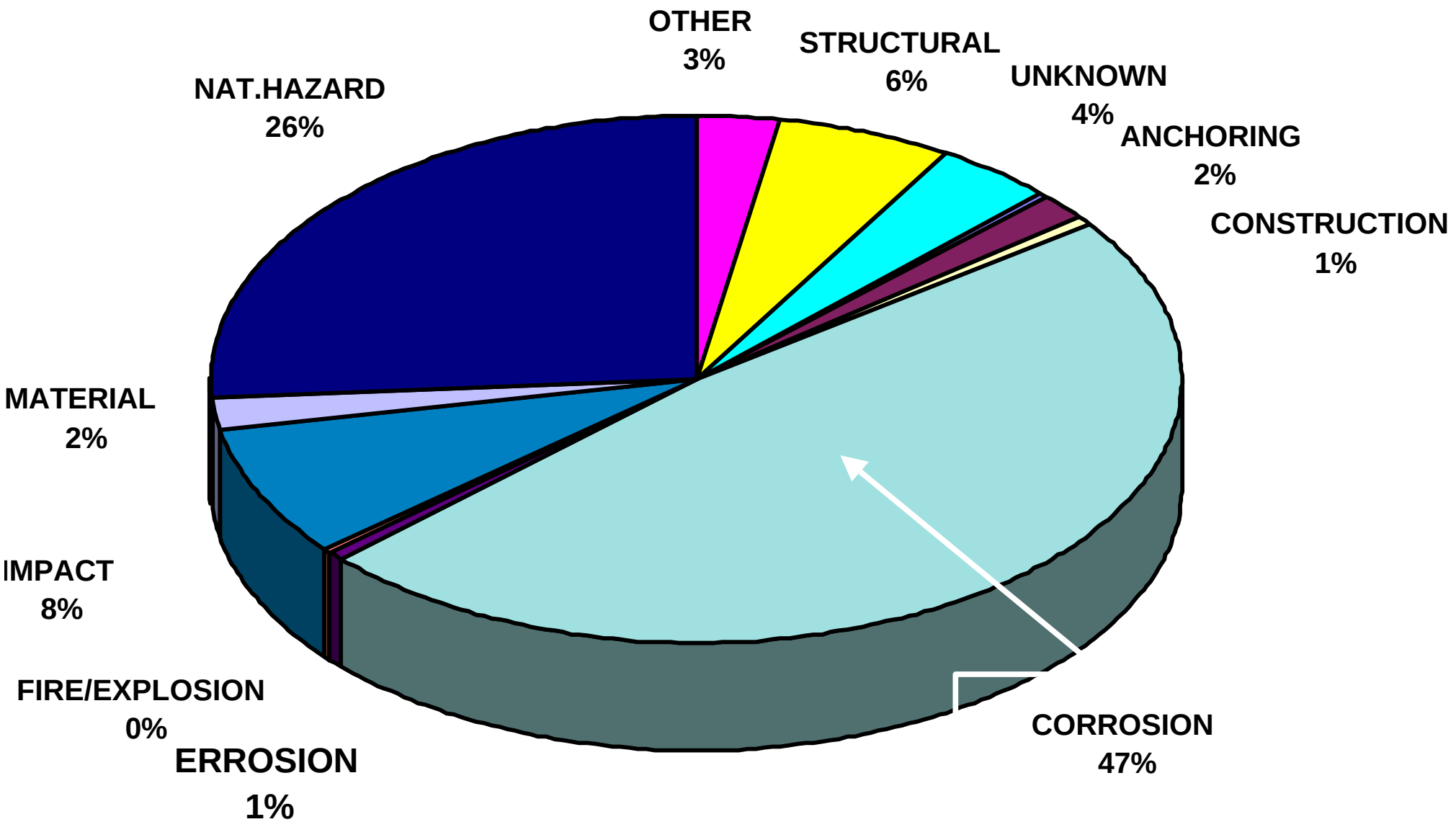



2
1.6
1.2
0.8
0.4
.01
.1
1
5
10
20
30
50
70
80
90
95
99
99.9
99.99
Percent Š

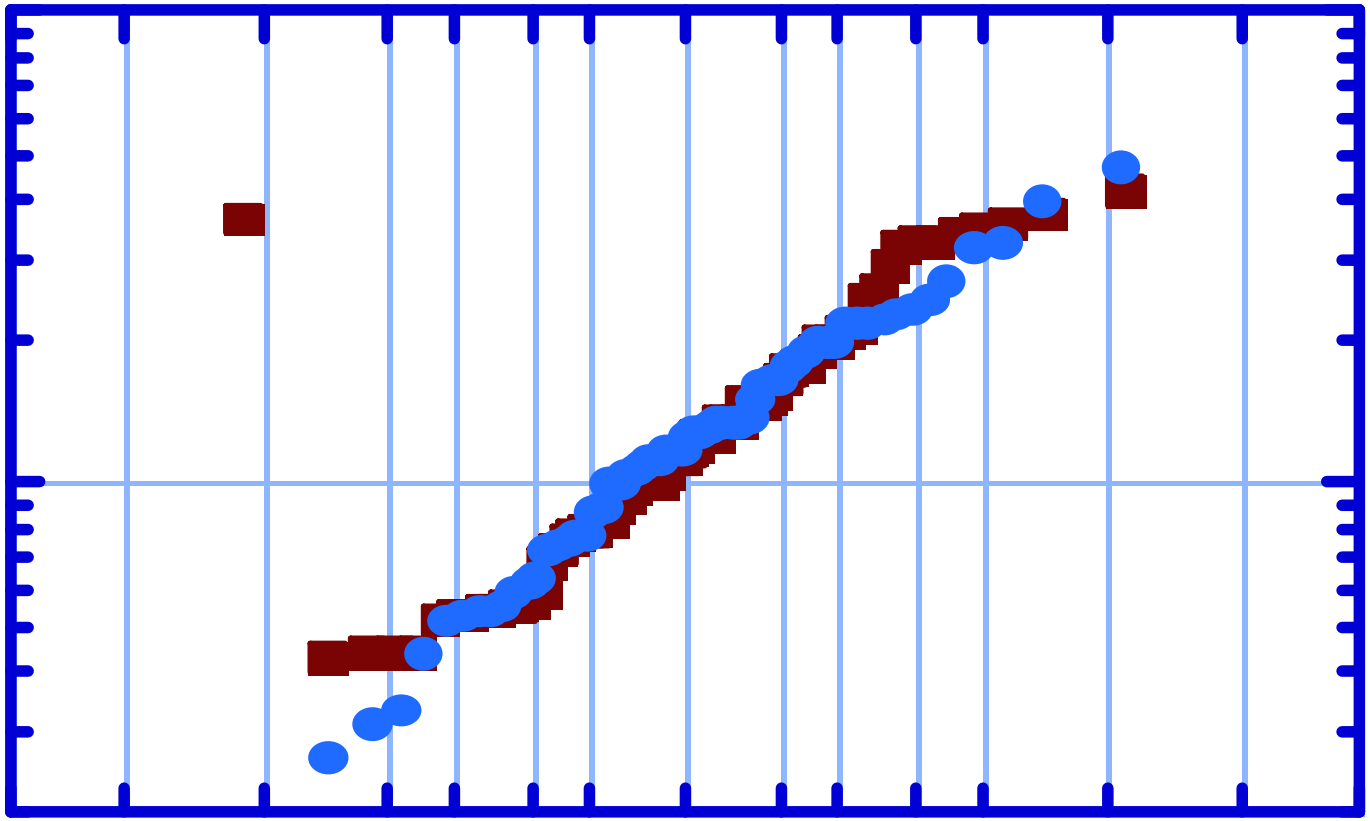
Gulf of Mexico Pipelines:
Pf " 1 to 2 E-3 per year



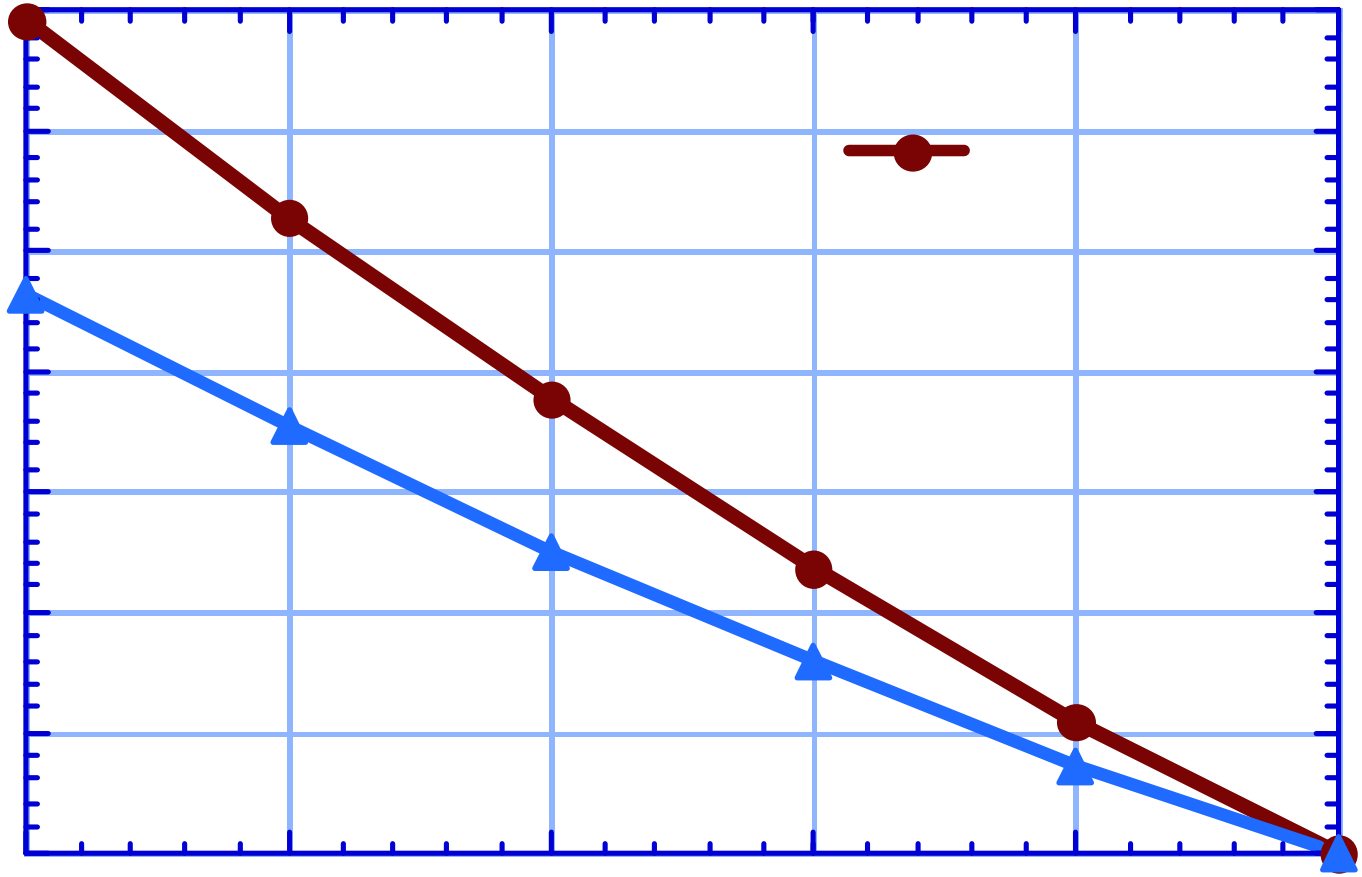
Corrosion is the Primary Problem



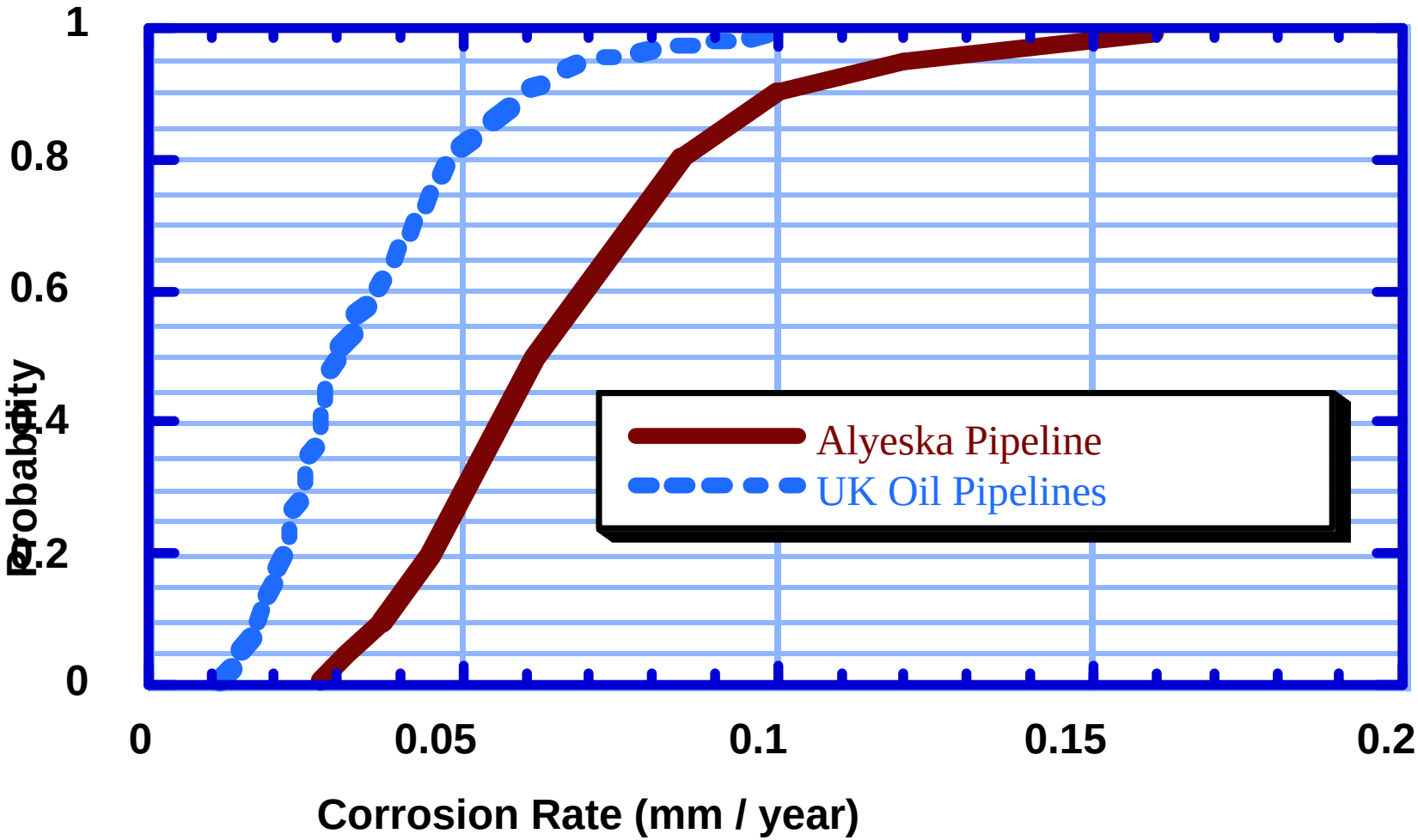
Corrosion Rates from Database



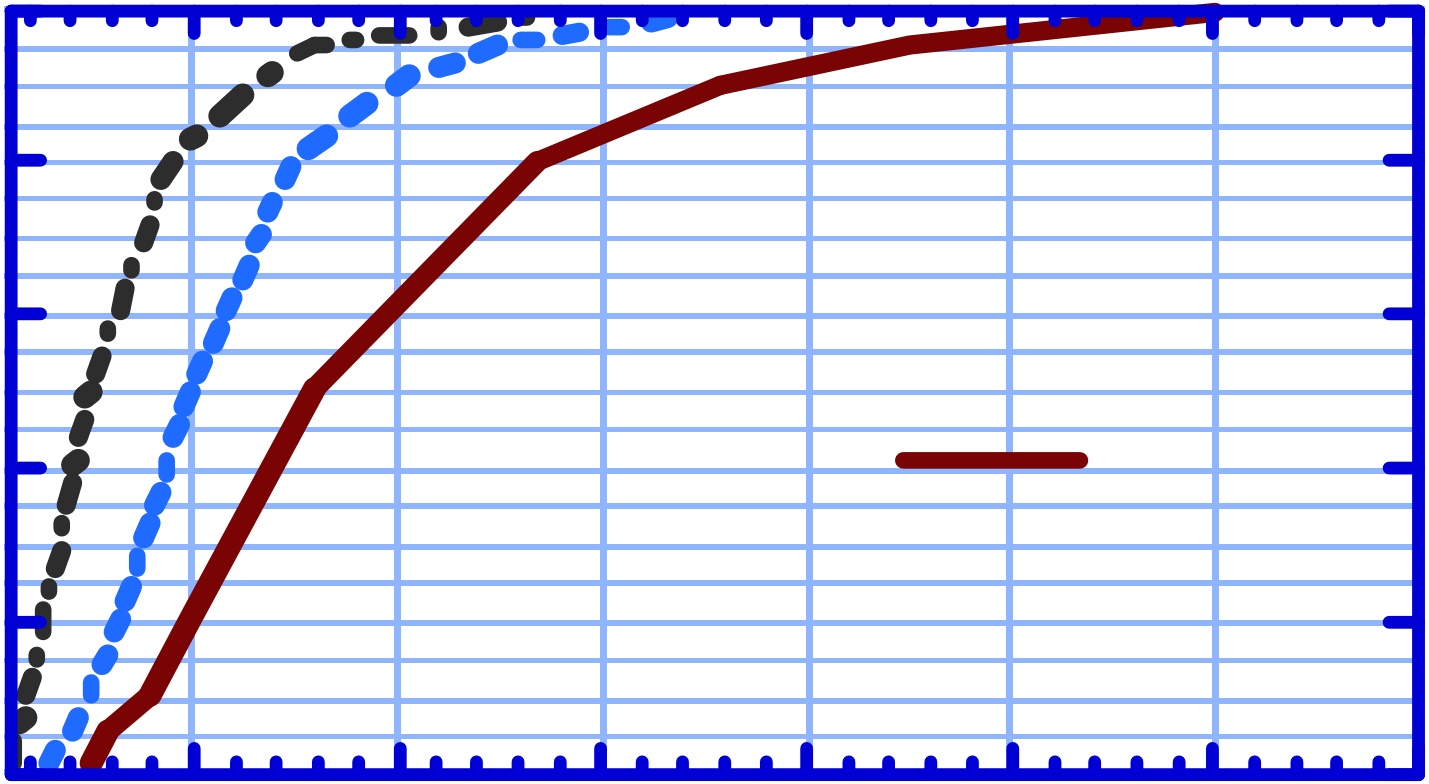
Time Dependent Reliability



Corrosion: Instrumented

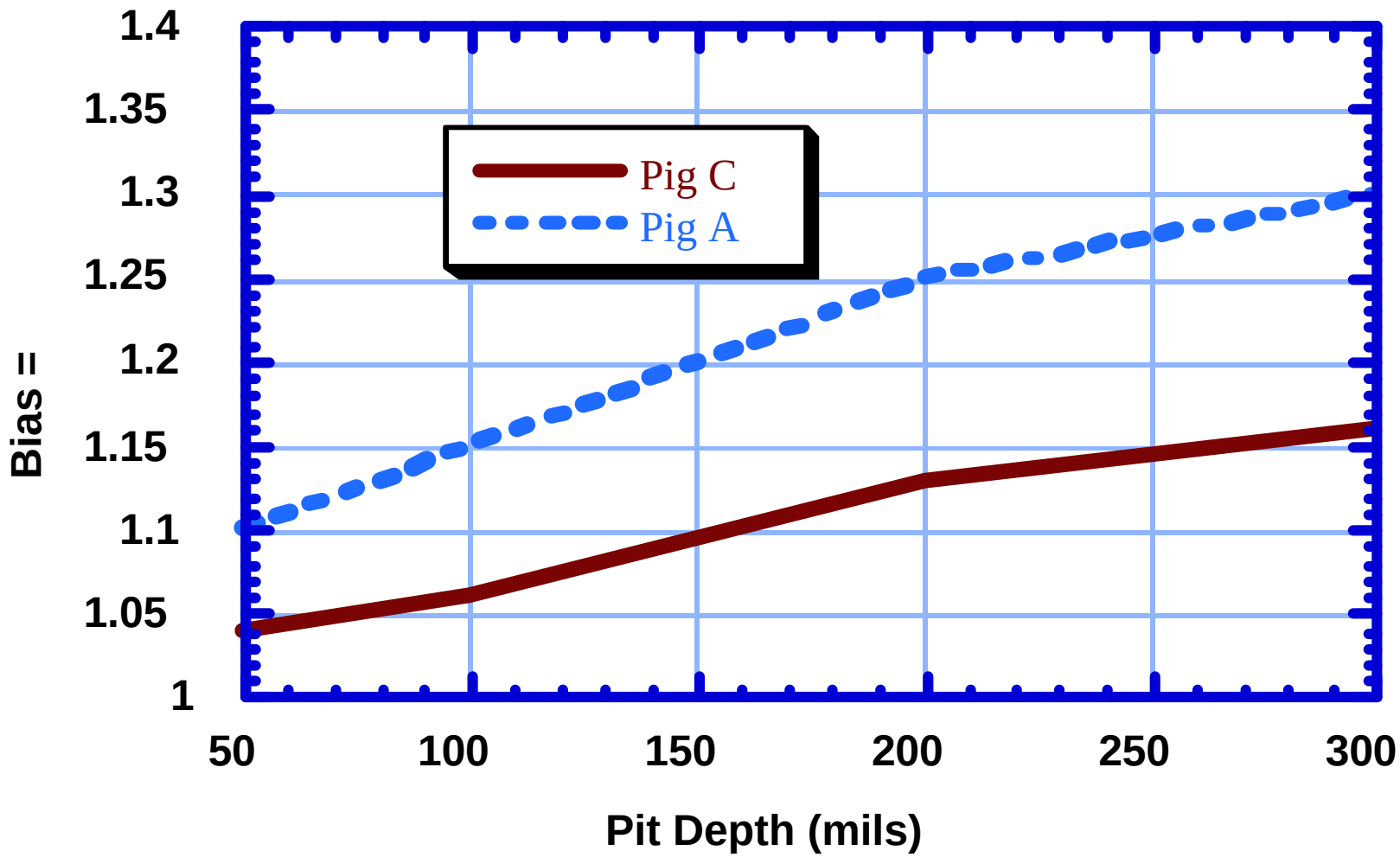


Probabilities of Detection

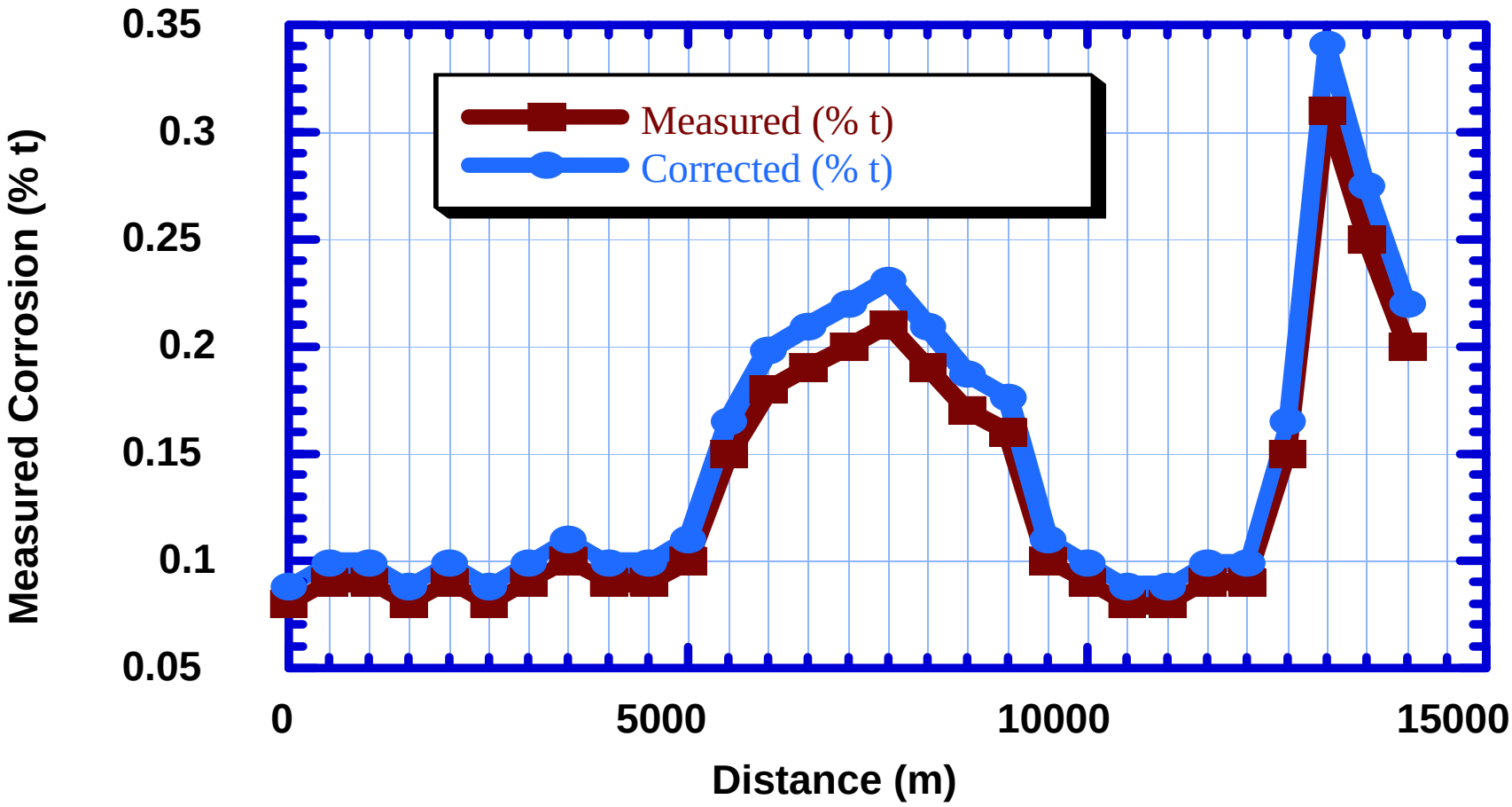


Measurement Accuracy

$t_{C50} = t_{CD}\ (\ B_{Dt}\ ),\ V_{tC50} = 25\ \%\ \text{to}\ 35\ \%$

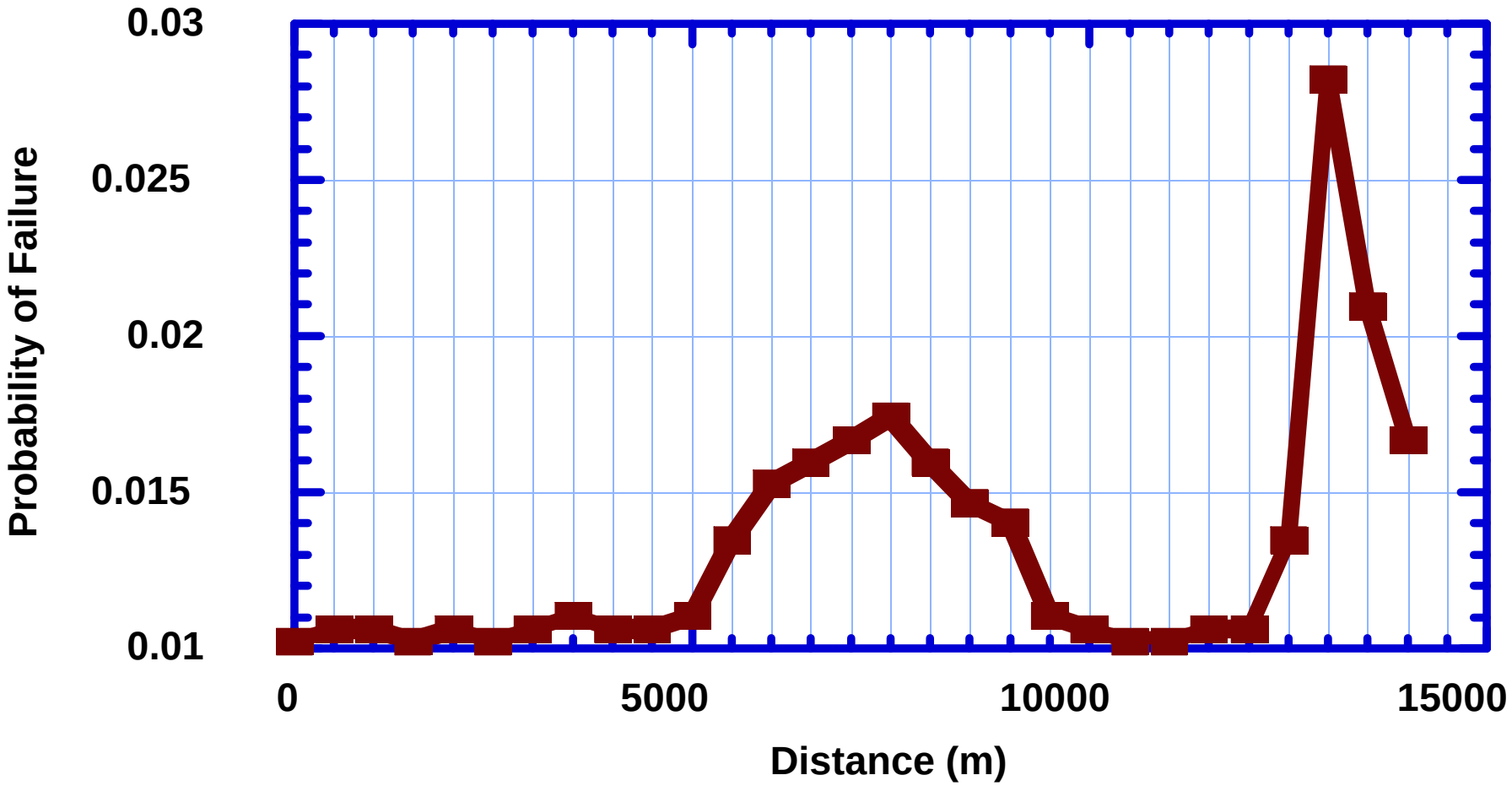


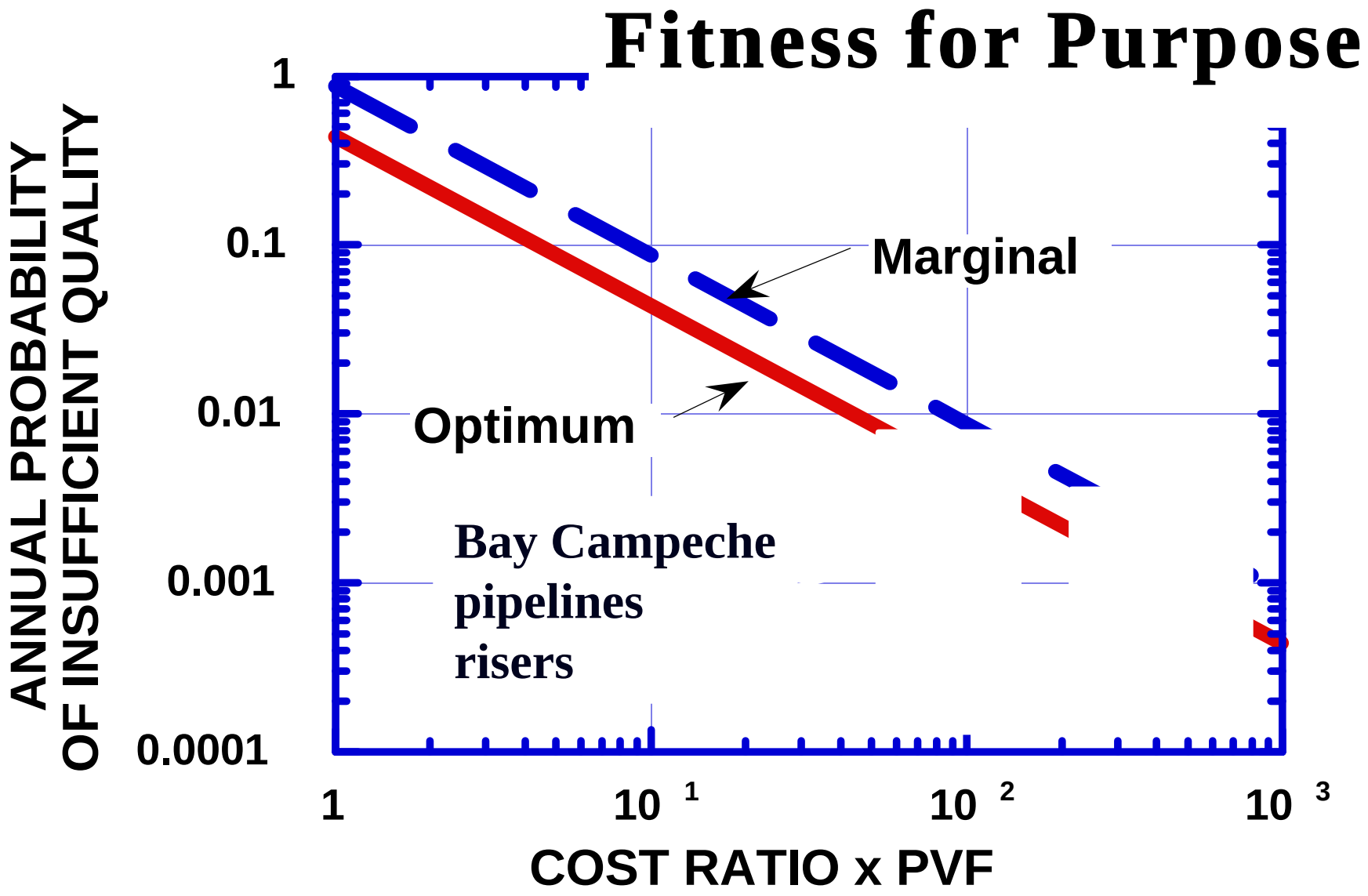
20-inch gas line instrumented Pig C



Probabilities of Failure:

Detected & Not Detected

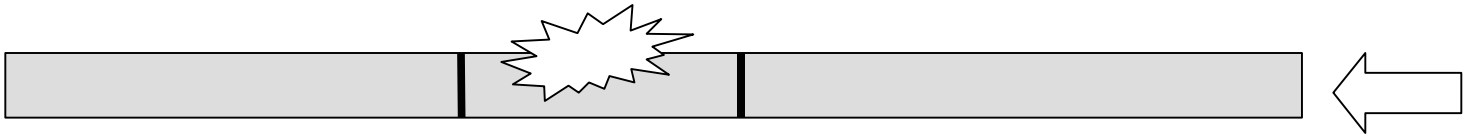



Fitness for Purpose
ANNUAL PROBABILITY
OF INSUFFICIENT QUALITY
1
0.1
0.01
0.001
0.0001
Marginal
Optimum
Bay Campeche
pipelines
risers
1
10 1
10 2
10 3
COST RATIO x PVF

Summary

- **RAM PIPE REQUAL approach to requalification of pipelines**
- **Corrosion is the primary problem**
- **Need to develop industry database on performance of marine pipelines**
- **RAM PIPE REQUAL project continuing with industrial guidance**

POP *(Performance of Offshore Pipelines)* Project



- **Pipelines proposed for abandonment**
- **In-line instrumented and un-instrumented**
- **Predictions of burst pressures & defects**
- **Hydrotest pipelines to failure & recover**
- **Perform material and geometry tests**
- **Revise predictions**

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